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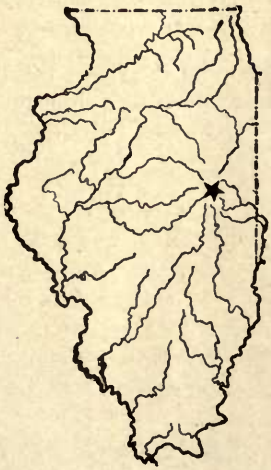
BALANCED VS. UNBALANCED RATIONS FOR DAIRY COWS

By WILBER J. FRASER AND CASSIUS C. HAYDEN



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Summary of Bulletin No. 159

1. This experiment was conducted with two lots of nine cows each for 131 days. Lot 1 was fed a balanced ration and Lot 2 an unbalanced ration. Page 238

2. Lot 1, fed a ration with a nutritive ratio of 1:6, produced 12,553.2 pounds more milk than Lot 2, fed a ration with a nutritive ratio of 1:11. This is a difference of 10.65 pounds milk per cow per day. Page 239

3. Lot 1, receiving the narrow ration, produced 359.56 pounds more fat than Lot 2, fed the wide ration. Page 241

4. Lot 1, receiving a balanced ration, consumed 54.59 pounds total digestible nutrients, and Lot 2, receiving the unbalanced ration, consumed 71.91 pounds total digestible nutrients, per hundred pounds of milk produced. Page 244

5. Lot 1, receiving a balanced ration, consumed 16.95 pounds total digestible nutrients, and Lot 2, receiving the unbalanced ration, consumed 21.02 pounds total digestible nutrients, per pound butter fat produced. Page 245

6. Conclusion. The quality of the ration fed affects the physical constitution of the cow, which in turn affects the consumption of feed and the production of milk. Page 246

BALANCED vs. UNBALANCED RATIONS FOR DAIRY COWS

By WILBER J. FRASER, Chief in Dairy Husbandry, and
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INTRODUCTION

The facts given in the following pages furnish a good example of the difference in value between a well-balanced, tho not ideal, and an unbalanced ration. Altho the standard balanced ration for dairy cows is fairly well determined, yet there are many dairymen who still persist in feeding a ration composed largely of corn and such roughage as corn stover, timothy hay, etc., which make an unbalanced ration. Taking the above facts into consideration, the Department of Dairy Husbandry deemed it wise to conduct an experiment to show the loss which may be sustained by dairymen who persist in feeding unbalanced rations.

Possibly it may be well to call to mind what is meant by a balanced ration. A balanced ration is one in which each of the different food materials or nutrients is present in just the right proportion and amount to meet the needs of the animal. If there is too much of either carbohydrates or protein, the excess becomes a waste; if there is too little of either, the others present will not be used to the best advantage. That the last statements are true, and that there is a large difference in the amount of milk produced from a balanced and from an unbalanced ration, has long been known, but it seems difficult for many dairymen to realize this fact. They fail to understand that quantity of feed cannot be made to take the place of quality and that there is a necessary connection between the nutrients in the feed and those in the milk; hence they are inclined to look at the cow as a machine which can turn any kind of feed which she will eat into the constituents of milk. She can no more do this than a mason can build a house with sand and brick without lime or cement; she may and does change the form of the nutrients of the feed, but she cannot put into her milk what she does not receive in her feed. She will build just so far as the material supplied her will permit, or up to the limit of her capacity.

If a cow were fed carbohydrates only, she would die in a short time; if she were fed fat only, she would die in a short time; if she were fed protein only, she would finally die. In each case she could make no milk without drawing on her body materials for

some portion of it. If the mason is short of cement, he can use more sand and build with a poorer mortar, but not so with the cow; she keeps the proportions in the milk practically the same, and when one material is lacking, the milk flow is limited by it regardless of how much of the other materials is present. Hence this experiment to show the extent of the losses involved in feeding unbalanced rations.

PLAN OF THE EXPERIMENT

This test started January 1, and continued until May 11, 131 days.

Twenty cows were divided into two lots of ten each. The two lots were as nearly equal in production and other characteristics as they could be divided, taking into consideration both their production at the time of the division and their previous records. Later it became necessary to remove one cow from Lot 1, and in order to keep the lots even a cow was removed from Lot 2 also.

After the two cows were removed, the average milk produced daily by Lot 1 during the preliminary week was 37.8 pounds per cow, and that by Lot 2, 36.18 pounds. This difference in production between the lots was somewhat greater than it was before the two cows were removed. There was a difference in fat in favor of Lot 2 which at least partly counterbalanced the difference in milk.

The two lots stood in the same line of stalls and were treated in every way alike except in the rations fed. Previous to starting the test they were all on the same well-balanced ration, which consisted of good clover hay, corn silage, bran, corn meal, and Buffalo gluten feed. The cows were producing well on this ration, and were all in good flesh and good physical condition. The treatment for several months previous had been the same for all the cows.

The feeds in the rations were maintained in the following proportions, each cow being given all she could eat up clean:

Lot 1		Lot 2	
Corn silage	30 pounds	Corn silage	30 pounds
Clover hay	8 "	Timothy hay	5 "
Gluten feed	4⅔ "	Clover hay	3 "
Ground corn	3⅓ "	Ground corn	8 "

The silage was made from well-eared, well-matured corn, and was of fine quality. The clover hay, timothy hay, and grains were of good quality, and the grains were finely ground. The ration fed to Lot 1 contained 1 pound of digestible protein to 6 pounds of digestible carbohydrates and fat, which is a well-balanced

ration for cows giving 40 pounds of milk daily. The ration fed to Lot 2 contained 1 pound of digestible protein to 11 pounds of digestible carbohydrates and fats, which is far too low a proportion of protein for even a dry cow; yet such rations are frequently fed to dairy herds.

RESULTS

When the change was made from the preliminary ration to the test rations, the cows in both lots decreased in milk flow, but Lot 2, receiving the unbalanced ration, decreased much more rapidly. This decrease continued in Lot 2 until that lot was producing but little more than two-thirds as much as Lot 1. At the end of the 131 days the cows in Lot 1 were in practically as good condition as when the test started, but those in Lot 2 ran down so rapidly in both flesh and condition that after 90 days the changing of their ration and the terminating of the experiment were seriously considered. This great difference was due to the lack of protein in the ration fed to Lot 2 and the lack of palatability in the timothy hay, of which the cows could not be induced to eat large amounts. Tho the timothy was cut and mixed with the clover, they managed to pick out the clover and ate the timothy only when forced to do so. It was practically impossible to induce the cows in Lot 2 to consume enough feed to supply sufficient protein for large quantities of milk.

Just such rations are fed to many Illinois dairy herds, the owner believing that it is only necessary to supply an abundance of feed, almost regardless of quality. When such unbalanced rations are fed, the cows do not keep in good physical condition and therefore *cannot consume as large quantities of feed nor produce as much milk.*

Lot 1, receiving the better ration, ate larger quantities of feed with greater relish, and kept in much better physical condition. They not only ate more feed, but made much better returns per 100 pounds of feed consumed. Seldom were any of the cows in Lot 1 "off feed," but in Lot 2 this frequently occurred.

RESULTS IN PRODUCTION OF MILK

Table 1 shows that the average difference in milk per cow per day during the preliminary week was 1.7 pounds in favor of Lot 1, which received the better ration. During the first week of the test this difference increased to 5.8 pounds per cow per day, during the seventh week to 13.2, and during the last five days to 12.2 pounds.

The average difference per cow per day for the 19 weeks was 10.65 pounds, and the total difference between the two lots was

TABLE 1.—AMOUNT OF MILK PRODUCED BY EACH LOT PER WEEK, DIFFERENCE PER WEEK, AND DIFFERENCE PER COW PER DAY

Week	Pounds milk per week			Pounds difference per cow per day
	Lot 1	Lot 2	Difference	
Preliminary	2384.7	2279.3	105.4	1.7
1	2315.8	1947 6	368.2	5.8
2	2189.6	1811.8	377.8	6.0
3	2205.1	1739.4	465.7	7.4
4	2259.0	1652.9	606 1	9.6
5	2271.6	1581.1	690.5	11.0
6	2229.7	1537.0	692 7	11.0
7	2253.8	1421.8	832.0	13.2
8	2259.5	1467.1	792.4	12.6
9	2198.7	1423.4	775.3	12.3
10	2121.3	1381.2	740.1	11.7
11	1990.9	1289.0	701.9	11.1
12	1986.6	1293.6	693.0	11.0
13	2000.6	1265.1	735 5	11.7
14	1989.1	1297.5	691.6	11.0
15	1961.8	1238.7	723.1	11.5
16	1976.1	1242.0	734.1	11.7
17	1918.8	1232.1	686 7	10.9
18	1905 8	1210.1	695.7	11.0
5 days	1359.2	808.4	550.8	12 2
Total	39393 0	26839.8	12553.2	10.65

12,553.2 pounds. The initial difference of 105.4 pounds of milk per week between the two lots, if carried thru the entire test would amount to a total of 1,973 pounds. This difference taken from the 12,553.2 leaves 10,580.2 pounds directly due to the difference in the rations. This difference for the lot during the entire period, due to the poor ration, was equal to 2½ times the average production of the cows fed the good ration. In other words, six and one-half cows receiving the balanced ration produced as much milk as the nine cows fed the unbalanced ration. 10,580 pounds of milk at $1.50 per hundred would be worth $158.70, the loss on nine cows for 131 days, which is $17.63 per cow, or practically 13c per cow per day. There was little difference in the average cost per hundred pounds of feed in the two rations. The timothy hay in the poor ration cost more than the clover hay in the good ration, while the gluten feed in the good ration cost more than the corn meal in the poor ration.

In Fig. 1 the space between each two horizontal lines represents 20 pounds of milk and the space between each two vertical lines represents one week's time, as indicated by the figures at the top and sides.

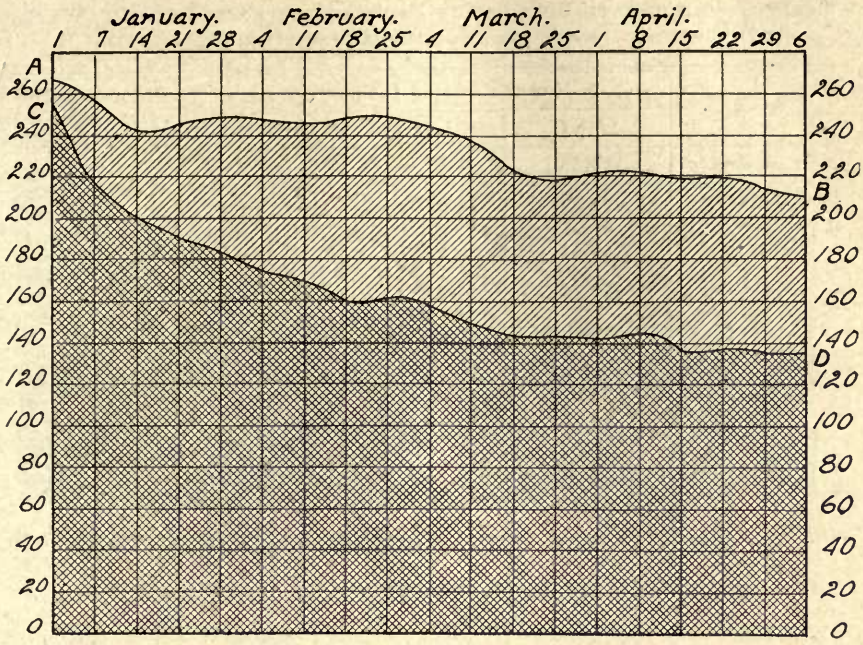

FIG 1. AVERAGE AMOUNT OF MILK PRODUCED PER COW IN EACH LOT

The shaded portion from the line O-O to the line A-B represents the average amount of milk produced per cow by Lot 1, getting the balanced ration. The double shaded portion from the line O-O to the line C-D represents the average amount of milk produced per cow by Lot 2, receiving the unbalanced ration. In other words, the space between the lines A-B and C-D represents the difference in milk produced per cow between the two lots.

RESULTS IN PRODUCTION OF BUTTER FAT

Table 2 shows that the production of fat varied in a manner similar to that of the milk. For one week previous to the beginning of the test each cow in Lot 2 produced .09 pounds of fat more per day than each cow in Lot 1, 5.9 pounds more for the entire lot for the week.

At the close of the first week of the test there was a difference of 4.69 pounds of fat in favor of Lot 1, making the difference from that of the previous week in production of the two lots, 10.59 pounds. The average difference per week was 19.18 pounds.

The total difference in production of fat between the two lots for the 131 days was 359.56 pounds. This is equivalent to 2½ times the average production of the cows in Lot 1; that is, six

TABLE 2.—AMOUNT OF BUTTER FAT PRODUCED BY EACH LOT PER WEEK, DIFFERENCE PER WEEK, AND DIFFERENCE PER COW PER DAY

Week	Pounds butter fat per week			Pounds difference per cow per day
	Lot 1	Lot 2	Difference	
Preliminary	77.58	83.48	—5.90	—.09
1	76.47	71.78	4.69	.07
2	65.15	59.21	5.94	.09
3	68.81	56.24	12.57	.20
4	71.66	54.87	16.79	.27
5	70.76	48.30	22.46	.36
6	71.10	50.31	20.79	.33
7	70.67	46.52	24.15	.38
8	70.21	46.22	23.99	.38
9	70.30	46.47	23.83	.38
10	70.37	46.85	23.52	.37
11	66.52	44.46	22.06	.35
12	66.02	46.08	19.94	.32
13	65.55	42.75	22.80	.36
14	63.55	44.33	19.22	.31
15	63.58	41.67	21.91	.35
16	62.71	41.83	20.88	.33
17	62.57	41.80	20.77	.33
18	59.62	39.98	19.64	.31
5 days	41.67	28.06	13.61	.30
Total	1257.29	897.73	359.56	.305+

and one-half cows on the balanced ration produced as much fat as the nine cows on the unbalanced ration. This 359 pounds of butter fat at 25 cents per pound would be worth $89.75. The loss on nine cows would be practically $10 per cow, besides the loss of skim milk, the injury to the cows, and the effect on their future production. This does not take into account the initial difference in butter fat between the two lots, which, if added thru the entire period, would make the difference in favor of the good ration much greater.

In Fig. 2 the space between each two horizontal lines represents one pound of butter fat and the space between each two vertical lines represents one week's time, as indicated by the figures at the top and sides.

The shaded portion from the line O-O to the line A-B represents the average number of pounds of fat produced per cow by Lot 1, getting the balanced ration, and the double shaded portion from the line O-O to the line C-D represents the average number of pounds of fat produced per cow by Lot 2, receiving the unbalanced ration. In other words, the space between the lines A-B and C-D represents the difference in fat produced per cow between the two lots.

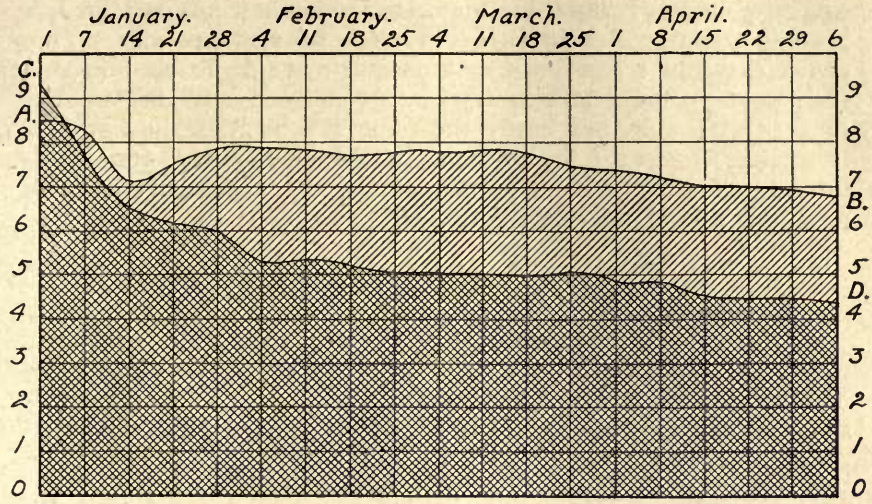

FIG. 2. AVERAGE AMOUNT OF BUTTER FAT PRODUCED PER COW IN EACH LOT

It will be noticed by Figs. 1 and 2 that it took between four and five weeks for both lots to settle down to approximately uniform production from these rations. This emphasizes the necessity of continuing such experiments for a long period of time before anything like rational conclusions can be drawn. Had the results of the first five weeks been excluded, the difference in production from the two rations would have been much greater, and would have been a more accurate comparison of the real efficiency of the two rations.

DIFFERENCE IN FEED CONSUMED

It was very difficult to keep the different feeds in the ration for Lot 2 in the exact proportions previously mentioned, because the cows did not readily consume the timothy hay; but the balance, or ratio of protein to carbohydrates and fat, was not materially changed. Because of the lack of protein and palatability in the ration, the cows in this lot ran down rapidly in flesh and condition, and for these reasons they were not able to make the best use of the feed consumed.

The total amount of feed consumed by Lot 1 was 59,840 pounds, and that consumed by Lot 2, 52,720 pounds, a difference of 7,120 pounds, which is 13.5 percent. The percentage of grain was a little greater in the ration for Lot 2, which would tend to give this lot the advantage. The feed eaten by Lot 1 contained

21,120 pounds of digestible nutrients, and that consumed by Lot 2 contained 18,768 pounds, a difference of 2,352 pounds. This shows that Lot 1 consumed 12.5 percent more digestible nutrients than Lot 2. Since the cows in Lot 2 consumed a smaller amount of feed and were practically the same size as those in Lot 1, a larger percentage of the nutrients would be required for maintenance, but they were not maintained, and a part of the milk produced was at the expense of body weight.

NUTRIENTS PER UNIT OF PRODUCT

The cows receiving the balanced ration not only consumed more digestible nutrients but they also made better returns per one hundred pounds of nutrients consumed. The following tables show the relation between the milk and fat produced and the nutrients consumed.

Tables 3 and 4 show that the nutrients consumed per 100 pounds of milk produced varied decidedly between the cows in the same lot. In Lot 1 the variation in protein was from 5.76 to 10.37 pounds, in carbohydrates from 33.52 to 59.74 pounds, in fat from 2.39 to 4.38 pounds, and in total nutrients from 44.66 to 79.97 pounds; in Lot 2 the protein varied from 4.77 to 7.36 pounds, the carbohydrates from 46.99 to 72.85 pounds, the fat from 2.43 to 3.73 pounds, and the total nutrients from 57.23 to 88.60 pounds.

The average amounts of nutrients consumed per 100 pounds milk produced were as follows: Lot 1, protein 7.12 pounds, carbohydrates 40.71 pounds, fat 3.00 pounds, and total nutrients 54.59 pounds; Lot 2, protein 5.99 pounds, carbohydrates 59.12 pounds, fat 3.03 pounds, and total nutrients 71.91 pounds. Lot 2 consumed 15.9 percent less protein, and 45.2 percent more carbohydrates, or 33.7 percent more total nutrients per 100 pounds of milk produced. While the cows in Lot 2 consumed less protein per 100 pounds milk produced, they lost greatly in weight, and undoubtedly a portion of this protein was used at the expense of their bodies.

The above discussion shows that the lot getting the balanced ration was able to consume 12.5 percent more nutrients and to make 33.7 percent better use of the nutrients consumed.

TABLE 3.—AMOUNT OF MILK PRODUCED BY EACH COW IN LOT 1, AND AMOUNT OF NUTRIENTS CONSUMED PER 100 POUNDS OF MILK PRODUCED

Cow No.	Milk produced	Digestible nutrients consumed per 100 pounds milk			
		Protein	Carbohydrates	Fat	Total nutrients*
1	4083.1	5.76	33.52	2.39	44.66
2	4317.2	7.03	40.24	2.99	54.00
3	3242.6	10.37	59.74	4.38	79.97
4	4552.6	6.64	37.57	2.80	50.51
5	5140.2	6.28	35.86	2.66	48.13
6	4373.0	6.85	39.04	2.89	52.39
7	4404.9	7.85	44.58	3.31	59.88
8	5473.1	6 30	35.85	2.66	48.14
9	3806.3	7.01	39.96	2.96	53.63
Average	4377.0	7.12	40.71	3.00	54.59

TABLE 4.—AMOUNT OF MILK PRODUCED BY EACH COW IN LOT 2, AND AMOUNT OF NUTRIENTS CONSUMED PER 100 POUNDS OF MILK PRODUCED

Cow No.	Milk produced	Digestible nutrients consumed per 100 pounds milk			
		Protein	Carbohydrates	Fat	Total nutrients*
1	2008.5	6.30	62.52	3.18	75.97
2	2329.9	6.73	66.79	3.47	81.33
3	4123.2	4.77	46.99	2.43	57.23
4	3520.5	5.59	53.79	2.77	65.61
5	3913.1	4.91	48.52	2.52	59.10
6	3317.7	5.68	55.98	2.86	68.10
7	2487.7	7.36	72.85	3.73	88.60
8	2626.3	6.95	69.00	3.50	83.83
9	2512.9	5.63	55.67	2.82	67.65
Average	2982.2	5.99	59.12	3.03	71.91

Tables 5 and 6 show that the nutrients consumed per pound of fat produced were as follows: In Lot 1 the protein varied from 1.78 to 2.78 pounds, with an average of 2.21 pounds; the carbohydrates varied from 10.45 to 16.01 pounds, with an average of 12.65 pounds; the fat varied from .75 to 1.17 pounds, with an average of .93 pounds. In Lot 2 the protein varied from 1.31 to 2.11 pounds, with an average of 1.75 pounds; the carbohydrates varied from 12.90 to 20.32 pounds, with an average of 17.28 pounds; the fat varied from .65 to 1.05 pounds, with an average of .89 pounds. This shows that in producing a pound of fat 24 percent more total nutrients were used with the poorly balanced ration. It will be noted that the difference is not so great as in the case of the milk.

*To obtain the total nutrients, the fat was multiplied by 2¼ because fat contains 2¼ times as much energy as an equal weight of carbohydrates or protein.

TABLE 5.—AMOUNT OF FAT PRODUCED BY EACH COW IN LOT 1, AND AMOUNT OF NUTRIENTS CONSUMED PER POUND OF FAT PRODUCED

Cow No.	Butter fat produced	Digestible nutrients consumed per 1 lb. fat			
		Protein	Carbohydrates	Fat	Total nutrients
1	131.00	1.78	10.45	.75	13.92
2	118.15	2.57	14.70	1.09	19.72
3	121.00	2.78	16.01	1.17	21.42
4	136.73	2.21	12.52	.93	16 82
5	150.16	2.15	12.27	.91	16 47
6	153.53	1.95	11.12	.82	14.92
7	152.31	2.27	12.89	.96	17.32
8	172.31	2.00	11.39	.84	15.28
9	122.10	2.18	12.46	.92	16.71
Average	139 70	2.21	12.65	.93	16.95

TABLE 6.—AMOUNT OF FAT PRODUCED BY EACH COW IN LOT 2, AND AMOUNT OF NUTRIENTS CONSUMED PER POUND OF FAT PRODUCED

Cow No.	Butter fat produced	Digestible nutrients consumed per 1 lb. fat			
		Protein	Carbohydrates	Fat	Total nutrients
1	88.43	1.43	14.20	72	17.25
2	85.13	1.84	18.28	.95	22.26
3	112.66	1.75	17.20	.88	20.93
4	93.18	2.11	20.32	1.05	24.79
5	117.37	1.64	16 17	.84	19.70
6	94.37	2.00	19.68	1.01	23.95
7	92.62	1.98	19.56	1.00	23.79
8	105.54	1.73	17.17	.87	20.86
9	108.43	1.31	12.90	.65	15.67
Average	99 75	1.75	17.28	.89	21.02

CONCLUSION

The quality of the ration affects the physical condition of the animal, and the physical condition vitally affects consumption and production. The cows on the poor ration lost greatly in flesh during the test and their subsequent production was reduced.

Lot 1, receiving the balanced ration, produced approximately one-third more than Lot 2, receiving the unbalanced ration. Six and one-half cows on a ration with a nutritive ratio of 1:6 produced as much as nine cows on a ration with a nutritive ratio of 1:11.

Because of the lack of protein in the ration fed Lot 2, the other nutrients were not used to the best advantage. This shows in a striking manner that an excess of carbohydrates cannot be made to take the place of a deficiency of protein.